United Nations ECE/ENERGY/GE.3/2015/5

Economic and Social Council

Distr.: General
20 February 2015

Original: English

Economic Commission for Europe

Committee on Sustainable Energy

Expert Group on Resource Classification

Fifth session
Geneva, 28 April – 1 May 2015
Item 15 of the provisional agenda
Case studies and testing of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009

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Norwegian Petroleum Directorate 2014 Case Study: The 2013 Norwegian Petroleum Resource Accounts presented according to UNFC-2009

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I. Introduction

1. One of the Norwegian Petroleum Directorate's (NPD) most important tasks is to maintain an overview of all of the petroleum resources on the Norwegian continental shelf.

2. The objective is to ensure that the resources are managed in the best interests of the Norwegian society.

3. The NPD collects and analyses data from the companies operating on the Norwegian continental shelf and compares this with the NPD's own data and forecasts. This information is an important management tool for the oil sector, and provides fundamental terms for developing the Government's budgets and oil policies.

4. Comprehensive, updated information and facts about the petroleum activities in Norway is available on the NPD's website[1], including various reports, fact-pages and fact-maps, etc.

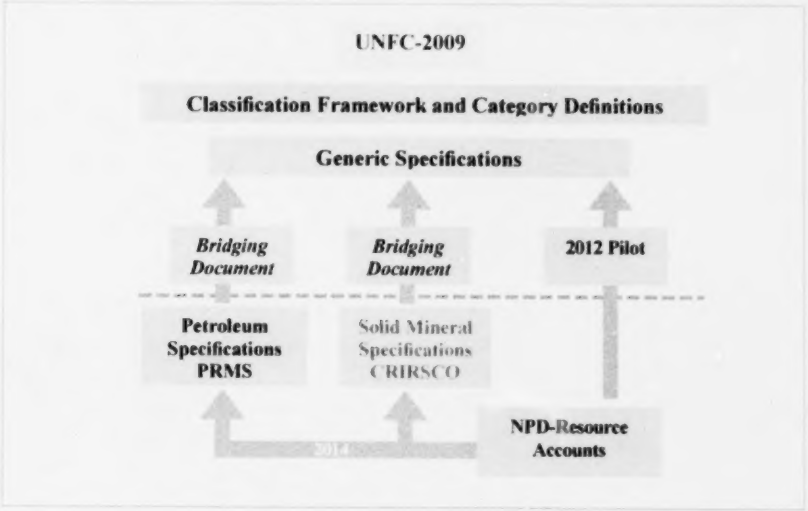
5. The NPD has been involved in the process of developing the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) since 2001. Firstly, as a member of the Ad Hoc Group of Experts on the Harmonization of Fossil Energy and Mineral Resources Terminology) and then subsequently in the Bureau of the Ad Hoc Group of Experts, the leader of the Petroleum Group, the co-leader of the Mapping Task Force, a member of the Specification Task Force Phase One, a member of the Expert Group on Resource Classification, a member of the Bureau of the Expert Group, a member of the Specification Task Force Phase Two, and most recently a member of the Technical Advisory Group. In all of these committees, the NPD has discussed definitions and terminology, representing the Government Resource Management stakeholder group.

6. This paper describes how the NPD has, in practical terms, used UNFC-2009 on the full portfolio of petroleum resources in Norway. In addition the paper also explains how the Pilot Study in 2012 was carried out. Direct mapping between the NPD classification and UNFC-2009 requires that a Bridging Document, explaining the connections between the two systems, is developed and consented to by the Expert Group on Resource Classification (or Technical Advisory Group). Since such a Bridging Document has not yet been established, the mapping of the Norwegian Resource Accounts for 2013 to UNFC-2009 has been carried out using the Bridging Document between the Petroleum Resource Management System (PRMS) endorsed by the Society of Petroleum Engineers (SPE) Board in March 2007 and endorsed by the World Petroleum Council (WPC), the American Association of Petroleum Geologists (AAPG), the Society of Petroleum Evaluation Engineers (SPEE) and the Society of Exploration Geophysicists (SEG) and UNFC-2009, included as Annex IV in ECE Energy Series No. 42 (ECE/ENERGY/94) "UNFC-2009 incorporating Specifications for its Application". The mapping through the use of this Bridging Document is the focus of this case study.

7. Figure 1 illustrates how the 2012 Pilot Study mapped the Norwegian numbers directly to the UNFC-2009 definitions and supporting explanations, while the conversion of the 2013 accounts undertaken in the 2014 Case Study was carried out using the UNFC-2009 Generic Specifications and the PRMS Bridging Document.

[1] http://www.npd.no/

Figure 1.
2012 Pilot study and 2014 case study mapping



II. The Norwegian Resource Classification System

8. Figures 2 and 3 show two ways of presenting the Norwegian Resource Classification System.

9. The system is "project based", which means that each project is classified in one of the categories. The three classes are the undiscovered resources, contingent resources and reserves. Each class consists of several categories. The names of the categories reflect the maturation of the projects:

(a) Undiscovered resources in Resource categories 8 and 9;

(b) Both new discoveries and possible future measures for improved oil recovery (IOR) which have not yet been evaluated in Resource category 7;

(c) Projects where recovery is not very likely in Resource category 6;

(d) Unclarified projects in Resource category 5;

(e) Projects in the planning phase in Resource category 4;

(f) Projects decided for development in Resource category 3;

(g) Approved development projects in Resource category 2;

(h) Producing projects in Resource category 1.

10. One of the requirements for the NPD Resource Classification System is that it should allow for the possibility of classifying and tracking the maturation of increased recovery projects. Therefore each Resource category, as illustrated here, has two attributes, the F-attribute for "First" and the A-attribute for "Additional" recoverable quantities that are coming from the same original oil and gas in place.

Figure 2.
The traditional way of presenting the Norwegian Classification System

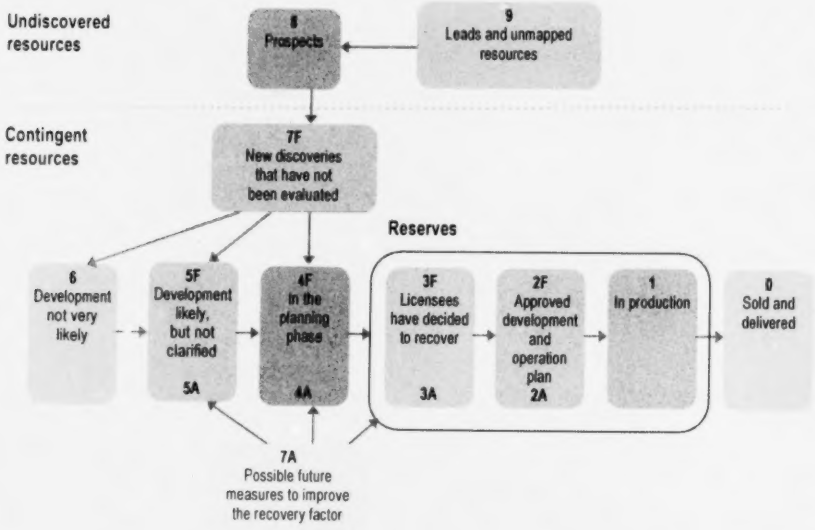


Figure 3.
The Norwegian Classification System

	NPD 2001			*Class*
		Category		
Discovered	Reserves	In production	1	Reserves
		Approved Plan for Development and Operation (PDO)	2F	
			2A	
		Licensees decided to recover	3F	
			3A	
	Contingent Resources	In the planning phase	4F	Contingent Resources
			4A	
		Recovery likely but undecided	5F	
			5A	
		Not yet evaluated additional potential	7A	
		Not yet evaluated	7F	
		Recovery not very likely		
Undis-covered	Undiscovered Resources	Prospect	8	Undiscovered resources
		Lead and Play	9	

11. The Norwegian Classification System requires that all resource estimates must describe a low estimate, a base estimate and a high estimate.

12. The low estimate must be lower than the base estimate. The probability of being able to recover the stated estimate or more must be stated (e.g. P90 or P80). Unlike the base estimate, the low estimate should be an expression of possible negative changes with respect to the mapping of the reservoir, reservoir parameters, or the recovery factor.

13. The base estimate must reflect the current understanding of the extension, characteristics and recovery factor of the reservoir. The base estimate will be calculated deterministically or stochastically. If the base estimate is calculated using a stochastic method, it must correspond to the mean value.

14. The high estimate must be higher than the base estimate. The probability of being able to recover the stated estimate or in excess of this must be stated (e.g. P10 or P20). Unlike the base estimate, the high estimate must be an expression of possible positive changes with respect to the mapping of the reservoir, reservoir parameters, or the recovery factor.

15. In comparing the Norwegian system to UNFC-2009, it is noticed that the G-axis of UNFC-2009 corresponds to the NPD definitions of Low, Base and High estimates. See figure 4.

16. If calculations are done by a stochastic method, the NPD system offers some flexibility for choosing which levels of confidence to use, but reporting guidelines recommend P90 (low), P50 (mean) and P10 (high). These levels of confidence are supposed to reflect all uncertainties; either they are of geological or technical reasons.

17. In the NPD system, the same "High", "Base" and "Low" labels are also used for undiscovered resources whilst in UNFC-2009, volume estimates of undiscovered resources are all represented in G4. However, in the Generic Specifications there is an option to create sub-classes of this, to represent different confidence levels of the estimates.

Figure 4.

Comparing the Norwegian classification system to UNFC-2009

Discovered resource		G1	Low estimate
		G1+G2 (Best estimate)	Base estimate
		G1+G2+G3	High estimate
		G4	Base estimate
Undiscovered resources	UNFC-2009 Generic Specification P[a]	G4.1	Low estimate
		G4.1+G4.2 (Best estimate)	Base estimate
		G4.1+G4.2+G4.3	High estimate

[a] Expansion of G4 to account for uncertainty

III. The 2012 Pilot Study

18. The alignment of the NPD resource category estimates to a UNFC-2009 class estimate for the 2012 Pilot Study was done in two different ways:

(a) On a one-to-one basis: this is illustrated by the green boxes in figure 5. This was called "The General rules categorization method". The total aggregated volumes of each NPD Resource Category were mapped to only one UNFC-2009 Sub-category.

(b) On a specific project basis: this approach required that more information on each project than the general information described by the Resource Category definitions

was considered for each individual project. As a result the estimate for some projects could also end up in the white boxes shown in figure 5.

19. Projects classified as Reserves in the Norwegian system, were mapped quite easily, as there were no alternatives. The estimates for all projects in one NPD Status Category go straight into the corresponding UNFC-2009 Sub-class. Hence, the mapping of the Commercial Project's Sub-classes was easily done.

20. However, for the "Contingent resources" additional sub-classes had to be considered in classifying the projects – i.e. some of the white boxes were used (See figure 5).

Figure 5.

Mapping to UNFC-2009

NPD Classes	*NPD Category*	*UNFC Sub-classes*
Reserves	1	E1.1F1.1
	2 F	E1.1F1.2
	2 A	E1.1F1.2
	3 F	E1.1F1.3
	3 A	E1.1F1.3
Contingent Resources	4 F	E1.1F2.1
		E2F2.1
		E1.1F2.2
	4 A	E1.1F2.1
		E1.1F2.2
		E2F2.1
		E2F2.2
	5 F	E1.1F2.1
		E2F2.1
		E1.1F2.2
		E2F2.2
		E3.2F2.2
	5 A	E1.1F2.1
		E2F2.1
		E1.1F2.2
		E2F2.2
	6	E3.3F2.3
	7 F	E2F2.1
		E2F2.3
		E3.2F2.1
		E3.2F2.2
		E3.2F3
	7 A	E2.F2.1
		E2,F2.2
		E3.2F2.2
		E3.2F3

Undiscovered Resources	**8**	**E3F3G4**
	9	**E3.2F3**

21. Table 1, from the 2012 Pilot Study, compared the results from taking the Norwegian resource estimates into UNFC-2009 by the two different methods just explained:

- Mapping of classes and sub-classes from the two systems by "General rules categorization method"; and
- Direct classification on an individual project basis.

22. Representation of the mapping at aggregated level through classes, shows only very minor differences between the two methods. For the classes of Commercial Projects and Exploration Projects the results are identical. The difference is seen in the Potential Commercial Projects Class and in the Non-Commercial Projects Class. Assuming that the Individual Project mapping is the correct mapping, the results from the general rules categorization differs by only four per cent for the Potentially Commercial Projects and by two per cent for the Non-Commercial Projects.

23. Presenting the mapping at the sub-class level shows larger differences between the two methods, as also shown in Table 1. This is to be expected, as the general rules categorization assumes that there are only one-to-one relationships between the sub-classes of the two classifications. Detailed mapping by projects demonstrate that in several cases one-to-many relationship exists, but only within the classes.

24. The summary of the 2012 Pilot Study presentation was:

- The differences between individual project classification and class mapping results are minor;
- This demonstrates that the mapping between the NPD system and UNFC-2009 was acceptable as a Pilot.

Table 1.

Results from the 2012 Pilot Study: Detailed mapping results (Norwegian Resource Accounts per 31 December 2011)

	Sub-classes				***Classes***	
UNFC-2009 Sub-class	*General rules categorization*	*Project individual categorization*	G1 + G2 Mill scm oil equivalent	*UNFC-2009 Sub-class*	*General rules categorization*	*Project individual categorization*
E1.1F1.1	2 347	2 347		E1F1	3 164	3 164
E1.1F1.2	433	433		E1F2	593	571
E1.1F1.3	384	384		E1F3	0	0
E1.1F2.1	593	432		E2F1	0	0
E1.1F2.2	0	139		E2F2	988	1 012
E2F2.1	798	728		E2F3	0	0
E2F2.2	190	284		E3F1	0	0
E3.2F2.1	182	181		E3F2	182	181
E3.2F3G4	2 455	2 455		E3F3	0	0
E3.3F2.3	0	0		E3F3G4	2 455	2 455
Total	**7 382**	**7 382**		**Total**	**7 382**	**7 382**

IV. 2014 Case Study

25. Up to 2012, only UNFC-2009 definitions and the concepts were available and approved, and discussions took place on how to use the concept on real cases for the various commodities. The NPD 2012 Pilot Study provided useful input.

26. In December 2013, the UNFC-2009 Generic Specifications were completed. The ECE ENERGY SERIES No. 42 includes Generic Specifications and approved Bridging Documents between PRMS and UNFC-2009 for petroleum and between the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) Template and UNFC-2009 for solid minerals.

27. The UNFC-2009 specifications require that when mapping other classification system to UNFC-2009, the relationship between the two systems must be documented in a Bridging Document which has been endorsed by the Expert Group on Resource Classification or by using an existing aligned system. So far only the PRMS is aligned for petroleum.

V. The Norwegian Petroleum Resource Accounts mapped to UNFC-2009

28. The Norwegian Petroleum Resource Accounts, as of 31 December 2013, are a comprehensive compilation of information from more than 800 projects, all of which are classified individually. Most of the projects are reported by the operating companies through the annual reporting in connection with the Revised National Budget reporting. The project aims to present the NPD resource account in the form of UNFC-2009.

29. The classification of each project according to the Norwegian System is discussed with the operating oil companies every year, during a process of establishing an inventory of all projects that the companies have to report to NPD, prior to the actual reporting. This inventory, or "project list" is a list of all projects with name and resource category. This is an iterative process, sending information back and forth. There is not always agreement, but in most cases the companies' opinion and the NPD's opinion regarding which category a project belongs to is the same. This is always carried out before the reporting deadline.

30. As part of the process of reporting the resource figures by the deadline, additional project information is made available to the NPD upon request. Examples of this are the so called "project stopper attributes" which will be explained later.

VI. Mapping estimates to UNFC-2009 by using the PRMS Bridging Document

31. The following hierarchy of instructions were used when mapping the Norwegian Resource Accounts to UNFC-2009 in 2014.

UNFC-2009 Definitions (Part I)

UNFC-2009 Specifications (Part II)

IV. National Resource Reporting

VI. Generic Specifications

B. Requirement of a Bridging Document

Annex IV. Bridging Document from PRMS

32. The first step was to map the Norwegian system to the PRMS. This was, in practical terms, quite simple. According to the definitions and specifications of the two systems, there is a "reasonable" one-to-one relationship between the two:

(a) A project in Norwegian RK1 will be classified in the category "On production" in PRMS (and given the code 1 in the Bridging Document).

(b) A project in Norwegian RK2 will be classified in the category "Approved for development" in PRMS (and given the code 2 in the Bridging Document).

(c) A project in Norwegian RK3 will be classified in the category "Justified for development" in PRMS (and given the code 3 in the Bridging Document).

(d) A project in Norwegian RK4 will be classified in the category "Development pending" in PRMS (and given the code 4 in the Bridging Document) even if the definitions in the two systems are somewhat different. Some of the RK4 projects could also be defined as "Development on hold". However, this ambiguous "general rule categorization" is compensated in the last step when allocating specific UNFC-2009 Sub-classes to individual projects where the PRMS-mapping allow for alternative "routes".

(e) A project in Norwegian RK5 will be classified in the category "Development on hold" in PRMS (and given code 5 in the Bridging Document), even if the definitions in the two systems are different. Some of the RK5 projects, it could be argued, belong to "Development Pending". However, to avoid being too progressive, this was not done for the 2014 case study.

(f) A project in Norwegian RK6 will be classified in the category "Development not viable" in PRMS (and given the code 7 in the Bridging Document).

(g) It should be noted that both the Norwegian RK 7F and RK 7A will end up in "Development unclarified" (and given the code 6 in the Bridging Document). See table 2.

Table 2.
Step 1: Bridge from the Norwegian system to PRMS

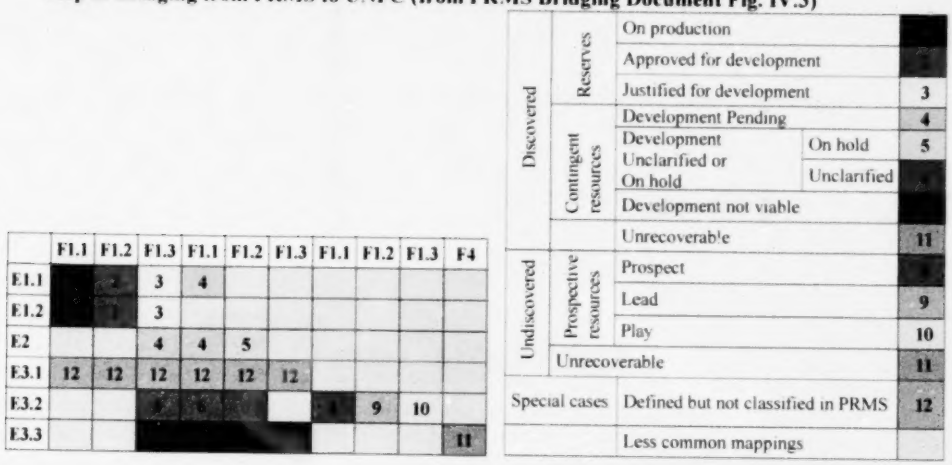
	NPD Category				*PRMS*		*PRMS Bridging*
	Class	*Sub-class*	*Main*	*Sub*			
Project A	Reserve	In production		F+A	Reserve		
Project B	Reserve	Approved for development	RK2	F	Reserve	Approved for development	2
Project C	Reserve	Approved for development		A			
Project D	Reserve	Decided for development	RK3	F	Reserve	Justified for development	3
Project E	Reserve	Decided for development		A			
Project F	Contingent Resource	In planning phase	RK4	F	Contingent Resource	Development pending	4
Project G	Contingent Resource	In planning phase		A			
Project H	Contingent Resource	Recovery Likely, but undecided	RK5	F	Contingent Resource	Development on hold	5
Project I	Contingent Resource	Recovery Likely, but undecided		A			
Project J	Contingent Resource	Not evaluated/ Improved rec pot		F	Contingent Resource		
Project k	Contingent Resource	Not evaluated/ Improved rec pot		A			
Project L	Contingent Resource	Recovery not very likely	RK6	F+A	Development not viable	Development not viable	7
Project M	Undiscovered	Prospect			Prospective Resources		
						Lead	9
Project O	Undiscovered	Lead and play	RK9			Play	10
					Specified but not classified		12

33. Step two is to look at how the PRMS classes are mapped to UNFC-2009: this is very well described in the Bridging Document between PRMS and UNFC-2009 (See figure 6).

34. Figure 6 shows how each PRMS Project Maturity Sub-class is mapped along the E- F Matrix, using the UNFC-2009 Sub-categories.

Figure 6.

Step 2: Bridging from PRMS to UNFC (from PRMS Bridging Document Fig. IV.3)



35. Step three is to replace the UNFC-2009 codes with the Norwegian Resource categories (figure 7). It should be noted that there are several alternatives. The challenge is where to put each of the project estimates.

36. This challenge is also commented on in the Bridging Document, Chapter IV, B. However, there is no guidance on how to deal with this, except by referring to the UNFC-2009 Sub-category definitions themselves.

Figure 7.

Norwegian resource category codes inserted (PRMS colour codes used)

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3.1	F3.2	F3.3	F4
E1.1		RK2	RK3	RK4						
E1.2		RK2	RK3							
E2			RK4	RK4	RK5					
E3.1										
E3.2			RK7	RK7	RK7				RK9	
E3.3										

37. Fortunately the challenge is now reduced due to the fact that some combinations are not possible according to the Norwegian situation and the Norwegian specifications:

(a) No subsidized projects exist (e.g. all E1.2 boxes are not used);

(b) No RK4 projects fulfil F1.3 definition because it is not expected that very detailed studies have been undertaken before the decision to deliver a Plan for Development and Operation (PDO) has been taken;

(c) No RK7 projects should be classified higher than F2.2 (e.g. F2.1), because these projects will normally be less mature than the RK5 projects which are classified in category F2.2;

(d) The Bridging Document code 12, non-sales production, is not classified in the NPD system, as in PRMS.

38. Figure 8 illustrates which alternatives still exist: two boxes for RK4, two boxes for RK8, one box for RK9 and four boxes for RK6.

Figure 8.

Intermediate mapping of NPD project categories to the E-F Matrix by use of the PRMS Bridging Document

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3.1	F3.2	F3.3	F4
E1.1		RK2	RK3	RK4						
E1.2										
E2				RK4	RK5					
E3.1										
E3.2					RK7				RK9	
E3.3										

39. In order to proceed, the following solution was found: RK4 projects required more information on each individual project. RK8 and RK9 were combined in the "Main" F3 class, and all RK6 estimates were put in the "least valuable box" which is E3.3,F2.3 ("least valuable principle") . This is illustrated in figure 9.

Figure 9.

Final mapping of NPD project categories to the E-F Matrix by use of the PRMS Bridging Document

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3.1	F3.2	F3.3	F4
E1.1		RK2	RK3	RK4						
E1.2										
E2				RK4	RK5					
E3.1										
E3.2					RK7					
E3.3										

40. The last challenge left was how all the RK4 projects should be sorted as there were two possible alternatives. In the end, the same approach as that taken in the 2012 Pilot Study was used. Each project with one of the following "project stoppers": "Technology lacking", "Lack of infrastructure", "No gas solution" or "No commercial agreement" was downgraded on the E- and/or F-axis as shown below.

41. Based on this information, projects were moved from E1.1 to E2.1 as follows:

- Technology is lacking
    - RK4A (two projects from E1.1F2.1 to E2F2.1)
- Lack of infrastructure in the area
    - RK4F (two projects from E1.1F2.1 to E2F2.1)
    - RK4A (two projects from E1.1F2.1 to E2F2.1)
- No gas solution
    - RK4F (one project from E1.1F2.1 to E2F2.1)
- No commercial agreement

- RK4F (eight projects from E1.1F2.1 to E2F2.1)
- RK4A (move from E1.1F2.1 to E2F2.1).

42. Once the detailed mapping of all the projects into one specific UNFC-2009 Sub-class was completed, the G1+G2 estimates (mean value) for all the 800 projects were aggregated. Table 3 shows the aggregated values, both at a Sub-class and at a Class level.

Table 3.

The results from the 800 projects for G1 + G2 (mean value) presented for UNFC-2009 Sub-Classes and Classes

UNFC-2009 Sub-class	*Oil mill scm*	*NGL mill tonne*	*Conden-sate mill scm*	*Gas bill scm*	*Oil equivalent mill scm*
1.1.1.1+2	599	104	30	1437	2263
1.1.1.2.1+	224	15	6	217	474
1.1.1.3.1+	12	10	4	395	430
1.1.2.1.1+2	606	15	2	112	747
2.2.1.1+2	40	3	2	43	92
2.2.2.1+2	247	17	7	263	550
3.2.2.2.1+	278	1	12	186	478
3.3.2.1+2	0	0	0	0	0
3.2.3.4	1330	0	120	1490	2940

UNFC-2009 Class	*Oil mill scm*	*NGL mill tonne*	*Conden-sate mill scm*	*Gas bill scm*	*Oil equivalent mill scm*
1.1.1+2	835	129	40	2049	3167
1.2.1+2	606	15	2	112	747
2.2.1+2	287	20	9	306	642
3.2.1+2	278	1	12	186	478
3.3.4	1330	0	120	1490	2940

Note:
Standard cubic metre oil equivalent (scm oe) is calculated so that:
1 scm of oil = 1 scm oe
1 scm of condensate = 1 scm oe
1 000 scm of gas = 1 scm oe
1 tonne of NGL = 1.9 scm NGL = 1.9 scm oe

VII. How G1 and G3 were calculated

43. The table (figure 10) of total resources with uncertainty (i.e. with G1 and G1+G2+G3 included) had to be constructed in two steps in order to achieve plausible results.

44. First, all G1, G1+G2 and G1+G2+G3 estimates for all projects were aggregated together using a stochastic aggregation tool. Dependencies between projects internally in each sub-class were included. This is called "envelope".

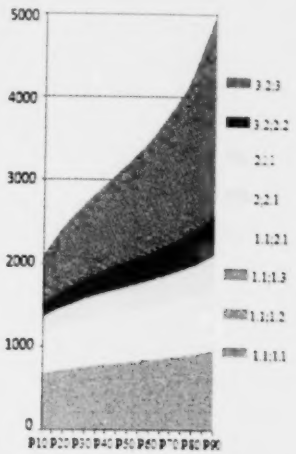
45. Thereafter all G1, G1+G2 and G1+G2+G3 estimates for all projects in each sub-class were aggregated together using a stochastic aggregation tool. The value of the high and low estimates for the Sub-classes was then adjusted proportionally to fit into the envelope. Figure 10 shows how the G-axis was used to illustrate the uncertainty of the resource accounts. It also shows how the "Examples of classes" in Figure 1 in UNFC-2009 fits to the Classes and Sub-classes used by NPD. The figure also demonstrates that other Sub-classes than the coloured ones (which have been given "labels") have been used. See Chapter IV Sub-classes (page 8 in the ECE Energy Series No. 42 (ECE/ENERGY/94) "UNFC-2009 incorporating Specifications for its Application) for information on how additional Sub-classes might be used.

46. An illustration of the distribution, similar to the one that NPD is presenting in its resource accounts (the "ski jump"), is also included figure 10.

Figure 10.

The Norwegian Petroleum Resource Accounts as of 31 December 2013 mapped to UNFC-2009

UNFC-2009 Class	*Oil mill scm*	*Oil mill scm*	*Oil mill scm*	*UNFC-2009 examples of classes with "labels"*
	G1	G1+G2	G1+G2+G3	
E1.1.F1.1	485	599	693	Commercial projects
E1.1.F1.2	182	224	264	
E1.1.F1.3	10	12	13	
E1.1. F 2.1	482	606	735	
E2.F2.1	28	40	54	Potential commercial projects
E2.F2.2	161	247	348	
E3.2.F2.2	170	278	485	
E3.3.F2	0	0	0	
	G4.1	G4.1+G4.2	G4.1+G4.2+G4.3	
E3.2.F3	588	1330	2442	Exploration projects



VIII. Summary

47. As a conclusion of this study, the following points are noted:

(a) It is feasible to present and communicate the NPD Annual Petroleum Resource Accounts by using UNFC-2009;

(b) Converting older historic Resource Accounts to UNFC-2009 cannot be undertaken based on classified project categories alone. Since more information than that which is provided by the Norwegian Resource Categories alone is required for classifying some projects, a more detailed study of all individual project attributes as reported at that time would be necessary;

(c) The differences between the NPD F and A attributes are not visible unless new Sub-categories are defined in UNFC-2009 (see ECE Energy Series No. 42 (ECE/ENERGY/94) "UNFC-2009 incorporating Specifications for its Application", Generic Specification A 'Use of numerical codes', last paragraph);

(d) The "least valuable principle" was used when it is not possible to separate detailed information between Sub-classes;

(e) UNFC-2009's ability to use more granularity than the example Classes shown in figure 1 in the ECE Energy Series No. 42 (ECE/ENERGY/94) "UNFC-2009 incorporating Specifications for its Application" is useful;

(f) There are a number of practical "challenges" in handling the G1 and G3 for a portfolio, as aggregation should be done by the stochastic method. Dependencies between the projects have to be taken into consideration.